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G1A AA3 AG6 AG9 AMQM AR6 AT27 AT3
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(56) Documents Cited
GB 2254916 A WO 96/08734 A2 JP 090315740 A
JP 090303042 A US 5493812 A

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UK CL (Edition Q) G1A AMQM AMQX
INT CL[6] B66B 13/06 13/14 13/26 , E05F 15/00 15/20 ,
G01V 8/10 8/20 , G08B 13/18
Online: WPIL, JAPIO

(54) Abstract Title
Lift door protection apparatus with power saving circuitry

(57) Infrared transmitters 3 and receivers 5 positioned on opposite lift doors 1a, 1b detect obstruction between the doors and reopen the doors if necessary. Circuitry connected to the receivers determines the position of the lift doors and reduces power supplied to the transmitters when the doors are closed or nearly closed and restores power when the doors are open. The power reduction is achieved by increasing the interval between sequential activation of the transmitter. This also increases the lifetime of the infrared transmitter diodes.

A further embodiment reduces power to the transmitters only after a predetermined delay period following door closure.

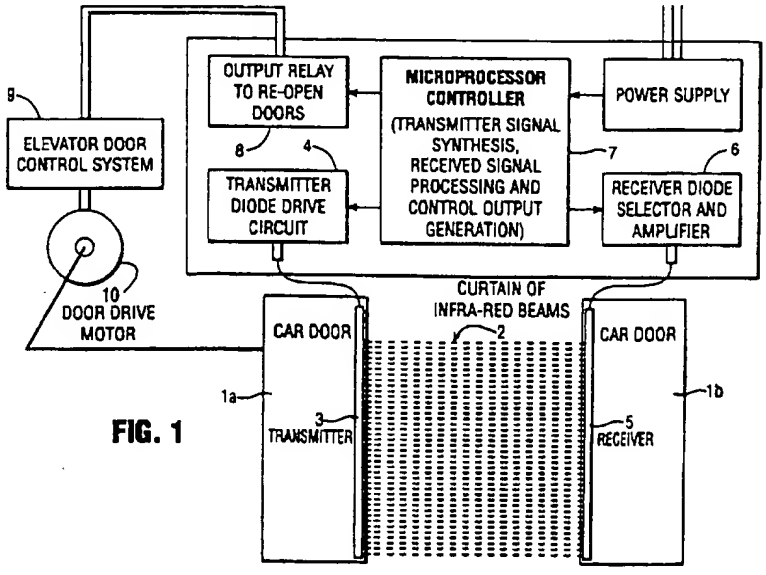


FIG. 1

GB 2 342 714 A

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

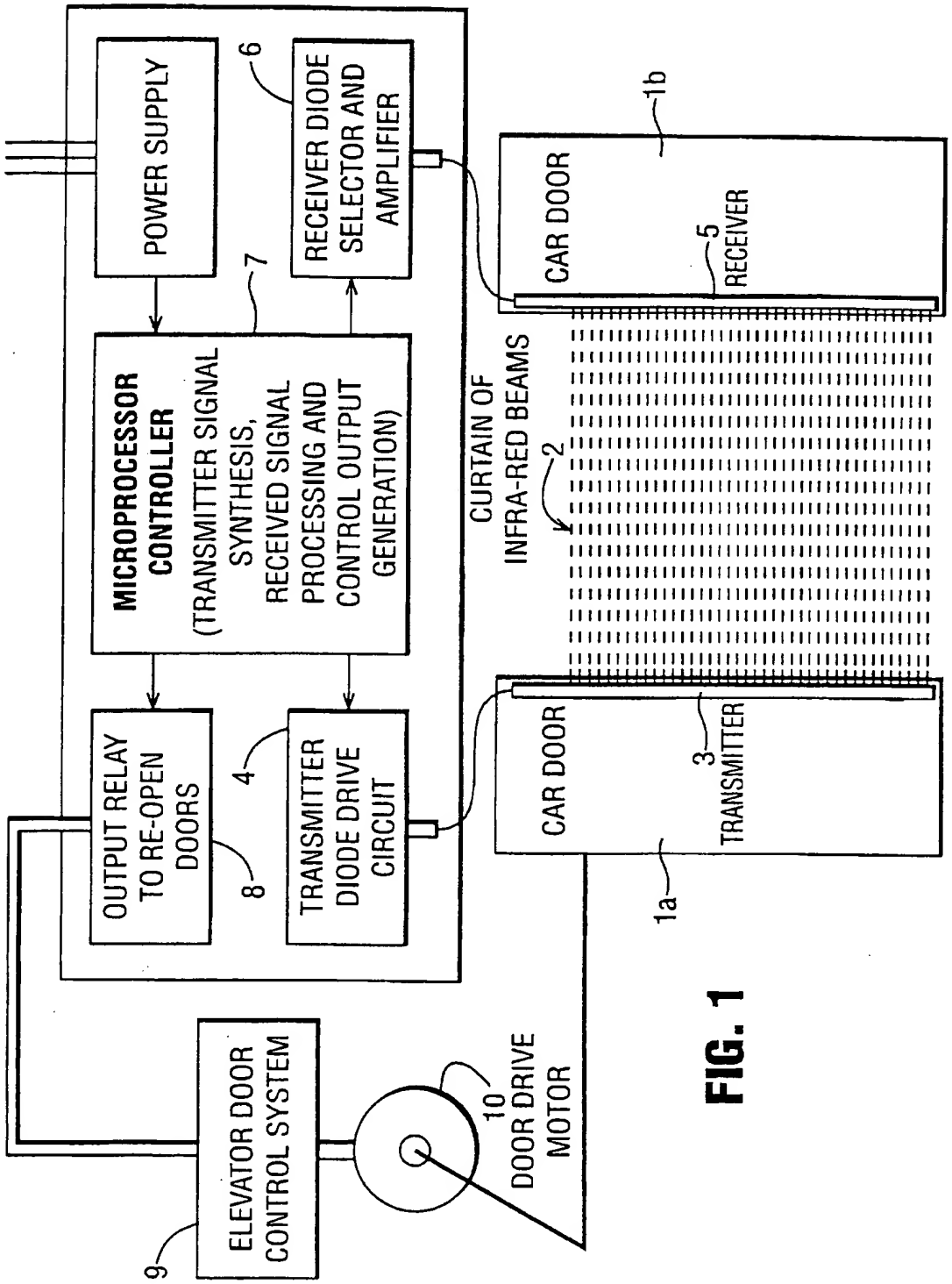

POWER SUPPLY
6
RECEIVER DIODE SELECTOR AND AMPLIFIER
7
MICROPROCESSOR CONTROLLER (TRANSMITTER SIGNAL SYNTHESIS, RECEIVED SIGNAL PROCESSING AND CONTROL OUTPUT GENERATION)
OUTPUT RELAY TO RE-OPEN DOORS
8
4
TRANSMITTER DIODE DRIVE CIRCUIT
ELEVATOR DOOR CONTROL SYSTEM
9
10
DOOR DRIVE MOTOR
CURTAIN OF INFRA-RED BEAMS
2
CAR DOOR
1b
5
RECEIVER
CAR DOOR
3
TRANSMITTER
1a

FIG. 1

FIG. 2

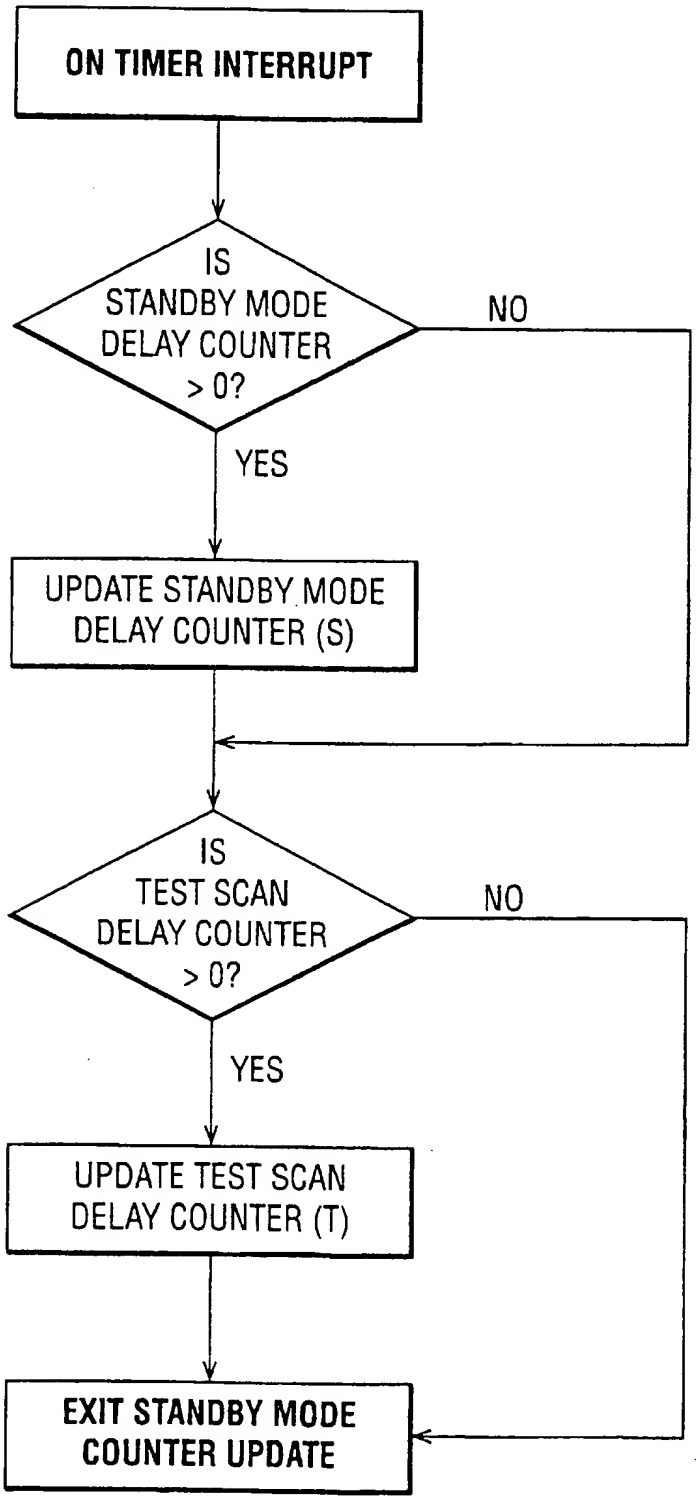
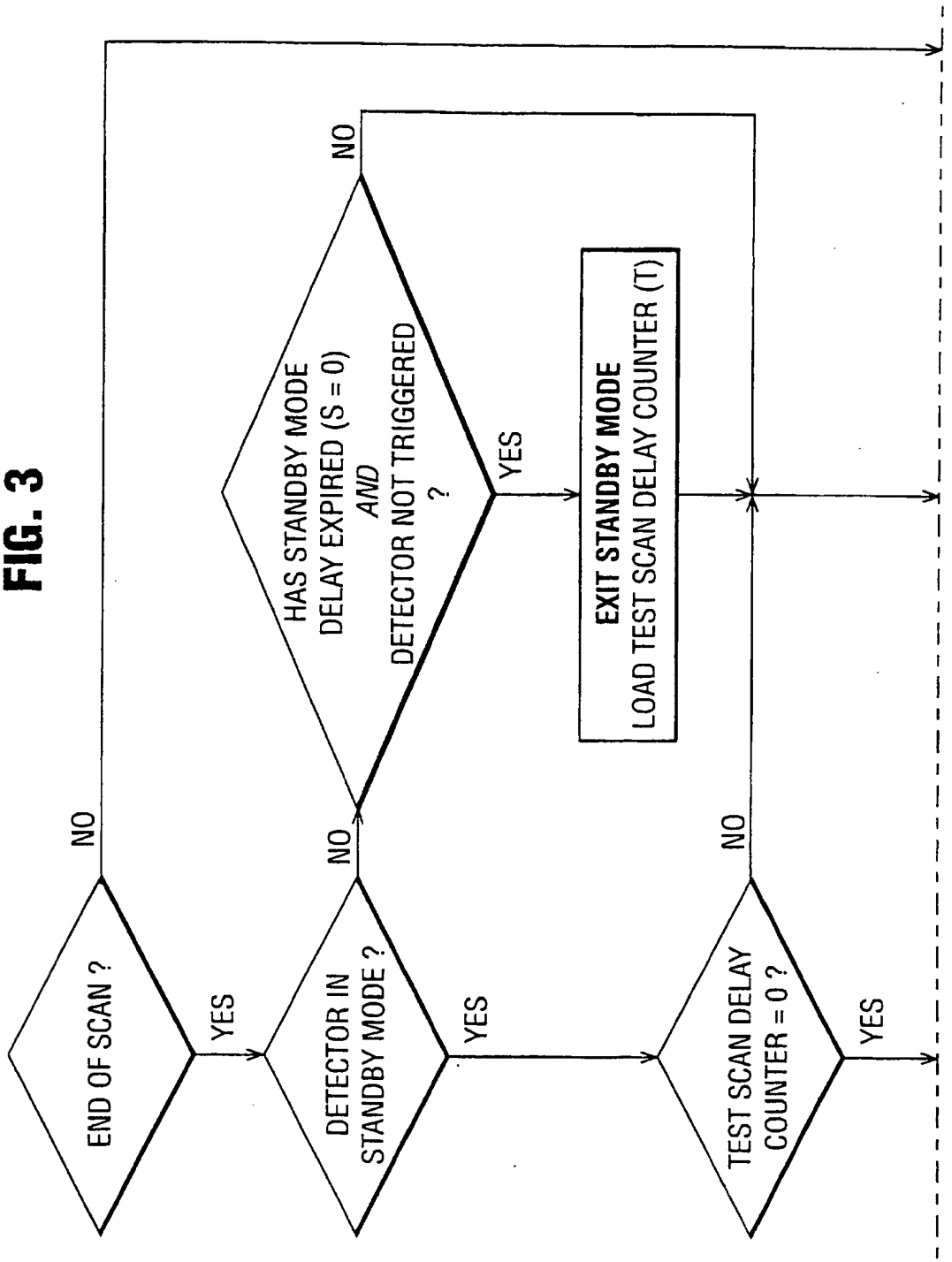

ON TIMER INTERRUPT
IS STANDBY MODE DELAY COUNTER > 0?
NO
YES
UPDATE STANDBY MODE DELAY COUNTER (S)
IS TEST SCAN DELAY COUNTER > 0?
NO
YES
UPDATE TEST SCAN DELAY COUNTER (T)
EXIT STANDBY MODE COUNTER UPDATE

FIG. 3


END OF SCAN ?
NO
YES
DETECTOR IN STANDBY MODE ?
NO
YES
HAS STANDBY MODE DELAY EXPIRED (S = 0) AND DETECTOR NOT TRIGGERED ?
NO
YES
EXIT STANDBY MODE
LOAD TEST SCAN DELAY COUNTER (T)
TEST SCAN DELAY COUNTER = 0 ?
NO
YES

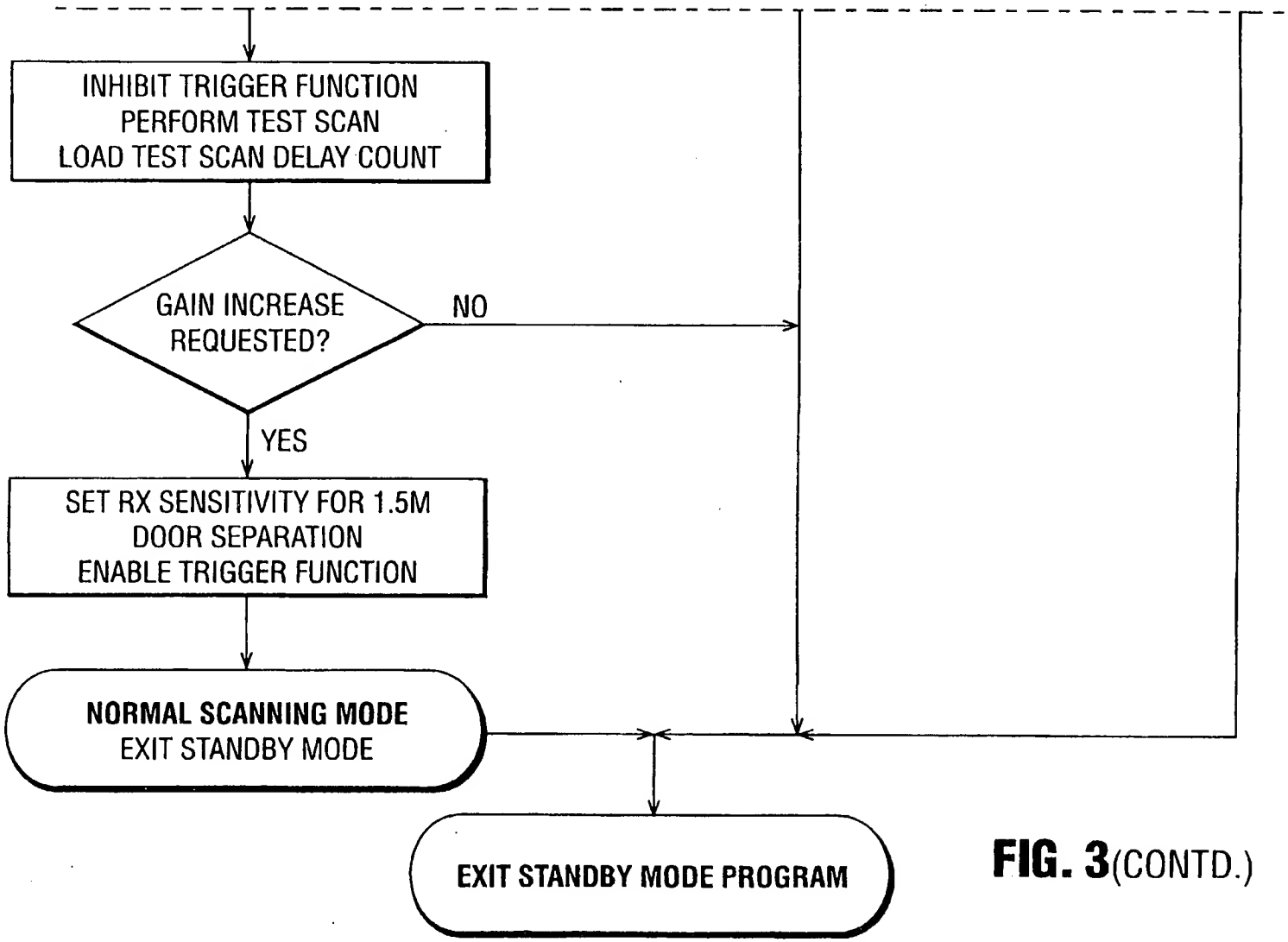

INHIBIT TRIGGER FUNCTION
PERFORM TEST SCAN
LOAD TEST SCAN DELAY COUNT
GAIN INCREASE REQUESTED?
NO
YES
SET RX SENSITIVITY FOR 1.5M DOOR SEPARATION
ENABLE TRIGGER FUNCTION
NORMAL SCANNING MODE
EXIT STANDBY MODE
EXIT STANDBY MODE PROGRAM

FIG. 3(CONTD.)

APPARATUS FOR REDUCING POWER CONSUMPTION IN A LIFT DOOR PROTECTION SYSTEM

This invention relates to apparatus for reducing power consumption in a lift door protection system. The invention is applicable to systems which have an "infrared curtain", for example, where infrared beam transmitter and receiver means simulate a grid of infrared beams across a lift door opening and where door control circuitry responds to the receiver output, when the beams are intercepted by an object in the lift door opening, to produce a drive signal to operate lift door control means for opening the door or doors. The invention enables the power consumption of infrared devices used in such systems to be reduced, when they are not needed to detect an object, thereby providing an improvement in lifetime and reliability.

A typical infrared beam curtain comprises a plurality of infrared emitting and receiving diode pairs, which are vertically spaced apart to simulate a grid-like barrier of infrared beams between a single door and a slampost, or between centre-closing doors, of a lift car. However, the infrared emitting diodes consume a significant amount of electrical power when operating continuously and this reduces their lifetime.

The present invention seeks to solve the latter problem.

WO-A-8402413 discloses a system which employs an infrared curtain and in which optical communication takes place, across the door gap, between transmitters and receivers attached to respective doors. However, this reference is primarily concerned with such "wireless" optical communication, whereby control information can be

transferred that causes different transmitter/receiver pairs to cooperate to create different infrared beam "patterns" across the door opening. The reference does not teach any technique for reducing the power consumed by infrared emitting diodes (which are subject to continuous scanning under normal operation), in order to extend their lifetime.

The invention solves this problem by providing apparatus for reducing power consumption in a lift door protection system, the system having infrared curtain means comprising infrared beam transmitter and receiver means which provide a beam or beams across a lift door opening; circuitry responsive to an output of the receiver means when the beam or beams are intercepted by an object in the lift door opening, in order to produce a drive signal; and lift door control means responsive to the drive signal for opening the door or doors in the event of beam interception; the apparatus comprising:

detection means which responds when (a) the lift door or doors are substantially closed, so that the usual power supplied to the transmitter means can be reduced; and (b) the lift door or doors are open or opening, so that the usual power supplied to the transmitter means can then be restored.

The detection means can respond when the lift door or doors are fully closed, but the invention would also work when there is a small gap (e.g. in which there is little or no danger of any object being trapped), between a single door and a slampost, or between centre closing doors. In any event, the power dissipation would not normally be reduced whilst there is any risk of an object intercepting the beam or beams, in the lift door opening, so as to ensure that

the doors will be opened in the event of beam interception.

Preferably, the detection means responds to the output of the infrared receiver means to cause the reduction or the restoration of power. For example, the output of the infrared receiver means can be used as a means of determining the distance between transmitter and receiver (when beam interception is ignored). Alternatively, or in addition, the output of the infrared receiver means will cease changing, due to lack of door motion, when the doors are closed. In a preferred embodiment of the invention, the average receiver output is monitored and when this has been steady for a predetermined period, power reduction can be initiated. The strength of the signal from the infrared receiver means is thereby usable to determine that the door or doors are substantially closed, assuming that there is no beam interception due to an object.

In order to take account of a slight possibility that an obstruction, having small dimensions, such as a dog lead or a child rein, might be trapped between the doors before intercepting a beam (to cause the doors to open), the detection means preferably incorporates time delay means which is set so that the power dissipation is reduced only after a predetermined delay following door closure. For example, a delay of 10 seconds from the "door closed" signal would suffice to avoid the aforementioned risk.

Preferably, means are included for maintaining the door or doors closed when the lift is not in use. This enables power consumption to be reduced during quiet spells and overnight, when the lift is essentially not in use.

In a typical installation which employs infrared emitter diodes as transmitters and receivers, each set of

corresponding transmitter/receiver pairs of diodes are "scanned" at a rate of about 800 diodes per second. For example, if there are 40 IR transmitter diodes (and hence 40 IR receiver diodes in the transmitter/receiver pairs), there are 20 scans/sec of the 40 pairs of diodes. This is equivalent to scanning 800 transmitter diodes each second whereby each transmitter diode receives power for a short period (1/800 second) every 1/20 second. During the period within which the transmitter diode of a diode pair is supplied with power, the transmitter emits an IR beam for the same period during which the receiver output is sampled to determine if there has been any beam interception. This is repeated for the next diode pair. The cycle is continuous from the first pair to the last pair, so that individual transmitter/receiver pairs receive power intermittently at a first cyclic rate.

In accordance with a preferred embodiment of the invention, when the doors are closed (preferably for a predetermined interval), the scanning rate of the set of diode pairs remains the same, but a dead space or standby period is introduced between the scans so as to conserve power, particularly the power supplied to the transmitters. This dead space or standby period which can be, for example, about 2 seconds, enables scanning to be maintained but at a much lower rate. As the individual transmitters (and receivers) receive power at a second cyclic rate lower than the first, the normally high power dissipation of the transmitter diodes can be drastically reduced. Surprisingly, this can reduce the power dissipation in the infrared diode emitters by a factor of about 40 times. As the diode emitters are subjected to more electrical stress than most other components in an infrared curtain and they consume about 50% of the power, a useful improvement in reliability and a reduction in wasted power is achieved.

Recovery from the reduced power dissipation to the usual power dissipation can be achieved rapidly as soon as the doors begin to open. For example, this can be within one scanning cycle of the transmitter/receiver diode pairs. As the average time for opening a lift door is about two seconds, a test scan can be completed well before there is any requirement for sensing an obstruction in the lift door opening.

As the lift doors in a typical building are closed for a large proportion of the time, especially during the night, the benefits of the invention can be particularly significant.

The embodiments of the invention will now be described with reference to the accompanying drawings, in which:

Fig. 1 is a schematic block diagram of an infrared curtain obstruction detection system which incorporates the invention;

Figs. 2 and 3 are flow diagrams showing how an embodiment of the invention can be implemented.

Referring to Fig. 1, a lift car comprises a pair of centre closing car doors 1a, 1b across which are projected a plurality of infrared beams 2. These simulate a grid of infrared beams which would be intercepted, for example, by a passenger entering or leaving the lift car. The beams 2 are projected by infrared transmitter diodes which are generally arranged in a vertical strip 3, which is attached adjacent to one closing edge of one door. The diodes are vertically spaced apart along the length of the strip 3, and are connected to a transmitter diode drive circuit 4. Circuit 4 provides power to each transmitter diode in turn,

whereby the respective beam of infrared is projected across the door opening. Hence, the grid of beams is made up of a sequence of beams which are generated when the emitter diodes are sequentially supplied with power. This cycle continuously repeats itself and there is normally little or no gap (nor dead space) between supplying the last and first diodes with power.

The beams 2 are received by corresponding infrared receiver diodes which are similarly vertically spaced apart in a strip 4. The outputs of these receiver diodes are connected to a receiver diode selector and amplifier circuit 6. Circuit 6 powers each receiver diode, although the power dissipation of the receivers is much less than that of the transmitters. When each receiver diode is powered, its output is scanned or sampled in the period in which the corresponding transmitter diode is supplied with power. The receiver outputs are thereby sequentially sampled in order to determine whether or not any transmitter beam has been intercepted. In the event of the interception of any beam, the circuitry 4 causes the microprocessor control 7 to generate a drive signal to an output relay 8, whereby an elevator door control system 9 energises a door drive motor 10, to cause the doors 1a, 1b to open. A power supply 11 provides power to the circuitry which includes the transmitter diode drive circuit 4, receiver diode selector and amplifier circuit 6, microprocessor 7 and relay 8.

In order to determine when the doors 1a, 1b are closed, the receiver output can be sampled as follows. With the receiver diodes operating with minimum gain in the circuitry 6, and with the doors closed, the maximum average signal of the diodes is measured for a period of S seconds (which is the "standby mode delay period"). If the

average signal does not change (i.e. because the doors are closed and no beam is intercepted), the circuitry operates so as to cause the system to enter the standby mode of operation. In a typical example, the transmitter/receiver diodes of each pair were separated by about 180mm, or less, with the doors closed and the average signal was measured with this separation (it will be realised that the signal strength will change as the doors move closer together or further apart). A substantially steady signal signifies substantial door closure. The delay period S can be set for about 10 seconds to ensure that it is safe to enter the standby mode of operation (i.e. so as to account for any small object which might become trapped in the closed doors). When the system is in the standby mode of operation, the transmitter/receiver diode pairs are "scanned" every T seconds (the test scan interval) and this may be typically about 2 seconds. During the test scan, the trigger function is inhibited, i.e. interception of a beam 2 does not cause the doors to open. If, as the result of a test scan, the receiver gain needs to be raised above a minimum level, then the receiver gain is set to a nominal value for a typical 1.5 metre door opening and normal scanning is resumed immediately with the trigger function enabled.

Microprocessor 7 is employed in order to carry out, inter alia, transmitter diode power supply, receiver output signal processing and control functions. It may be programmed in order to enter the standby mode in accordance with the following program. This program is also represented by the flow charts of Figs. 2 and 3.

Program

```
At End of each Scan
IF (rx gain at minimum)
```

```
{
     IF (detector in standby mode)
     {
          IF (test scan counter = 0)
          {
               Inhibit trigger function
               Perform Test scan
               IF (rx gain increase requested)
               {
                    Set rx gain = 1.5 metre
                    separation
                    Enable trigger function
                    Exit standby mode operation
               }
               ELSE
               {
                    Load Test scan delay count down
                    value (T)
               }
          }
     ELSE
     {
               IF (standby mode delay (S) = 0 AND detector
               not triggered)
               {
                    Enter standby mode operation
                    Load Test scan delay count down value (T)
               }
     }
}
.....................................................
ON (TIMER interrupt)
{
     IF (standby delay counter (S)!=0)
     {
```

```
            update standby delay counter
        }
        IF (test scan interval counter (T)!=0)
        {
            update test scan interval counter
        }
    }
```

CLAIMS

1. Apparatus for reducing power consumption in a lift door protection system, the system having infrared curtain means comprising infrared beam transmitter and receiver means which provide a beam or beams across a lift door opening; circuitry responsive to an output of the receiver means when the beam or beams are intercepted by an object in the lift door opening, whereby the circuitry produces a drive signal; and lift door control means responsive to the drive signal for opening the door or doors in the event of beam interception; the apparatus comprising:

detection means which responds when (a) the lift door or doors are substantially closed, so that the usual power supplied to the transmitter means can be reduced; and (b) the lift door or doors are opening, so that the usual power supplied to the transmitter means can be restored.

2. Apparatus according to claim 1, wherein the detection means is responsive to the output of the infrared receiver means to cause the reduction or restoration of said power dissipation.

3. Apparatus according to claim 2, wherein the detection means incorporates time delay means so that said power dissipation is reduced only after a predetermined delay following door closure.

4. Apparatus according to any preceding claim, including means for maintaining the doors closed when the lift is not in use.

5. Apparatus according to any preceding claim, wherein

the usual power supplied to each transmitter means is supplied intermittently at a first cyclic rate, and said power is reduced by supplying power intermittently to said transmitter means at a second cyclic rate which is less than the first.

6. Apparatus according to any preceding claim, wherein the transmitter and receiver means are normally scanned at a rate of N per second and power is reduced by interposing a standby interval between each scanning interval.

Amendments to the claims have been filed as follows

1. Apparatus for reducing power consumption in a lift door protection system, the system having infrared curtain means comprising infrared beam transmitter and receiver means which provide a beam or beams across a lift door opening; circuitry responsive to an output of the receiver means when the beam or beams are intercepted by an object in the lift door opening, whereby the circuitry produces a drive signal; and lift door control means responsive to the drive signal for opening the door or doors in the event of beam interception; the apparatus comprising:

detection means which responds when (a) the lift door or doors are substantially closed, so that the usual power supplied to the transmitter means can be reduced; and (b) the lift door or doors are opening, so that the usual power supplied to the transmitter means can be restored, and wherein the transmitter and receiver means are normally scanned at a rate of N per second and power is reduced by interposing a standby interval between each scanning interval.

2. Apparatus according to claim 1, wherein the detection means is responsive to the output of the infrared receiver means to cause the reduction or restoration of said power dissipation.

3. Apparatus according to claim 2, wherein the detection means incorporates time delay means so that said power dissipation is reduced only after a predetermined delay following door closure.

4. Apparatus according to any preceding claim, including means for maintaining the doors closed when the lift is not in use.

The Patent Office

INVESTOR IN PEOPLE

Application No: GB 9822359.7 **Examiner:** Anna Mackisack
Claims searched: 1-6 **Date of search:** 22 January 1999

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): G1A (AMQM, AMQX)

Int Cl (Ed.6): B66B 13/06 13/14 13/26, E05F 15/00 15/20, G01V 8/10 8/20, G08B 13/18

Other: Online: WPIL, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 2254916 A	TRETT see page 1 lines 26 to 33	1, 2, 4
X	WO 96/08734 A2	THOMSON see page 13 paragraph 3	1, 2, 4
X	US 5493812 A	TEICH	1, 2, 4
X	JP 090315740	OTIS ELEVATOR CO see abstract and figures	1, 2, 4 - 6
A	JP 090303042	TSUUDEN KK see abstract and figures	1, 2, 4

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

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Your Reference: P350407GB/RAL/EP
Application No: GB 0100079.3

3 October 2003

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Dear Sirs

Patents Act 1977: Examination Report under Section 18(3)

Latest date for reply: 5 April 2004

I enclose two copies of my examination report.

By the above date you should either file amendments to meet the objections in the enclosed report or make observations on them. If you do not, the application may be refused.

You should note that the normal unextended period allowed for complying fully with the requirements of the Act will end on 4 October 2004, that is 12 months after the date of this letter.

Yours faithfully

Sam Mirison
Sam Mirison
Examiner

†**Use of E-mail:** Please note that e-mail should be used for correspondence only.

Your ref: P350407GB/RAL/EP
Application No: GB 0100079.3
Applicant: Lear Corporation

Latest date for reply: 5 April 2004

Examiner: Sam Mirison
Tel: 01633 813548
Date of report: 3 October 2003

Patents Act 1977
Examination Report under Section 18(3)

Inventive step

1. The invention as defined in claims 1,3, 4, 5, 6, 7, 11, 12, 14, 15, 16, 17, 18, 19, 21 is obvious in view of what has already been disclosed in the following documents:

GB2342714 A (MEMCO LIMITED), as against the claims 1, 4, 6, 7, 11-12, 15, 16, 17, 19, 21. See the figures, abstract, and page 1 lines 19-22, page 3, line 34 to page 4 line 16 which describes that the presence of cyclic signal interrupts between IR transmitter-receiver pairs is detected. See also page 5 lines 29 to page 6 line 7, and page 6 lines 20 to 25 which describe that in the events that the signal interrupts of any beam is intercepted, the microprocessor controller 7 (figure 1) generates an activation signal to door drive motor 10 to open the door (i.e. reverse its closing movement). The schematic figure 1 also shows that the microprocessor controller is connected to the receiver, transmitter and the door drive. See also page 7 lines 26-28;

DE4321028 A (KESSLER), as against claims 1, 3, 11, 12, 18, 19, 21. See the figures and abstracts which describe a device for identifying of obstruction between moving parts, e.g. window and window frames of a vehicle, for protection against objects being trapped between the approaching parts. The WPI abstract also mentions that the system can be applied to the monitored space of the door-space of a folding door. It can use IR pulses, which relates to the term signal interrupts;

DE4028584 A (HEISS), as against 1, 3, 5, 12, 14, 19. see the abstract and figures which describe a non-contact optoelectronic obstruction detection system for a vehicle automatic sliding sun-roof window. The obstructions are detected by a pulsed IR sensing beam which is activated when the window servo drive motor is switched on. Figure 2 also shows that the controller is connected to both receiver and transmitter. The controller can switch off the drive motor when an obstruction is sensed. The sensor is a single sensor, disposed on the inner surface of the window jamb. Once again the definition of the pulsed signal is wide enough to relate to the term signal interrupts;

The GB'714 document shows a non-contact optoelectronic system for an automatic door closure of a lift. The system has IR transmitter, sensor (receiver) and controller module which monitors and processes the signal interrupts detected by the sensor to detect the obstruction between the transmitter-sensor, wherein the microprocessor controller generates a drive motor control signal to stop or reverse the lift door upon the detection of an obstruction between at least one transmitter-sensor pair. The transmitter-receivers can be mounted on a door and slampost, or be mounted on two doors. On the other hand, the DE ' 584 document shows that

[Examination Report contd.]

application of such obstruction detection systems have been known to the experts in automotive engineering field. It discloses the application of such systems used in an automatic sun-roof window. DE '028 also shows such a system used for automatic side windows of vehicles. DE' 028 further mentions that its system can also be applied to doors. It can therefore be argued that the person skilled in the art of the automatic door obstruction detection who has had the knowledge of GB'714 on one hand and the system of DE' 028 document on the other, will have seen the extension the GB'714 document for providing an automatic door closure detection of the vehicle doors as obvious. It follows that the claims indicated above, in particular your claims 1, 12 and 19, lack inventive steps.

Clarity and support

2. Page 7, lines 21-23, mentions that your detection system can also be implemented by ultra-sound waves. This raises doubt about the scope of your claims. However, if your amended claims are to include such features, you are advised to consider that the previously cited JP11-270229 A (ASMO) may be used as the basis of an objection.

3. Claim 1, line 7, and in claim 19 line 14, "the signal interrupts" has no antecedence. Similarly, in claim 12, line 13, the phrase "the signal interrupts" has no antecedence.

4. Claim 12, line 6, "a drive motor operatively connected to the *motor*" is unclear. According to the corresponding section of your claim 19, it appears that the intended word instead of "*motor*" should be "*the vehicle door*".